ATTORNEY'S DOCKET NO: **011435**

U.S. DEPARTMENT OF COMMERCE, PATENT AND TRADEMARK OFFICE		DATE: **November 5, 2001**
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLN. NO. (if known): 09/926446
INTERNATIONAL APPLICATION NO.: **PCT/JP00/02691**	INTERNATIONAL FILING DATE: **APRIL 24, 2000**	PRIORITY DATE CLAIMED: **MAY 6, 1999**

TITLE OF INVENTION: ***PROGRAMMABLE CONTROLLER***

APPLICANT(S) FOR DO/EO/US: **Youichi HASHIMOTO**

Applicant hereby submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. XX This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.

2. ___ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.

3. XX This express request to begin national examination procedures (35 USC 371(f)) at any time rather than delay examination until the expiration of the time limit set in 35 USC 371(b) and PCT Articles 22 and 39(1).

4. XX A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. XX A copy of the International Application as filed (35 U.S.C. 371(c)(2)):

   a. XX is transmitted herewith (required only if not transmitted by the International Bureau).
   b. _ has been transmitted by the International Bureau.
   c. ___ is not required, as the application was filed in the United States Receiving Office (RO/US)

6. XX A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. XX Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))

   a. ___ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ___ have been transmitted by the International Bureau.
   c. ___ have not been made; however, the time limit for making such amendments has NOT expired.
   d. XX have not been made and will not be made.

8. ___ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. _ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).

10. XX A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

ITEMS 11. TO 16. BELOW CONCERN OTHER DOCUMENT(S) OR INFORMATION INCLUDED:

11. __ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

12. _ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
ASSIGNEE NAME AND ADDRESS: ***KABUSHIKI KAISHA YASKAWA DENKI, Kitakyushu-shi, Japan***
Please publish the assignee data with the application.

13. XX A **FIRST** preliminary amendment.
___ A **SECOND** or **SUBSEQUENT** preliminary amendment

14. ___ A substitute specification.

15. ___ A change of power of attorney and/or address letter.

16. XX Other items or information: 3 sheets of drawings and international search report.

ATTORNEY'S DOCKET NO: **011435**

U.S. APPLICATION NO. (if known) 09/926446	INTERNATIONAL APPLICATION NO. **PCT/JP00/02691**	DATE: **November 5, 2001**

17. X The following fees are submitted:	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5): Search Report has been prepared by the EPO or JPO: $890.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) $710.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $740.00		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1040.00		
International preliminary examination fee (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$ 890.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than __ 20 x __ 30 months from the earliest claimed priority date (37 DVR 1.492(e)).	**$ 130.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
TOTAL	4 -20 =		X $ 18.00		
INDEPENDENT	1 - 3 =		X $ 84.00		
Multiple dependent claims(s) (if applicable)			+ $280.00		
TOTAL OF ABOVE CALCULATIONS =				**$1,020.00**	
Reduction by 1/2 for filing by small entity, if applicable. (Note 37 CFR 1.9, 1.27, 1.28).					
SUBTOTAL =				**$1,020.00**	
Processing fee of **$130.00** for furnishing the English translation later than __ 20 __ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +					
TOTAL NATIONAL FEE =				**$1,020.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00 per property +**					
TOTAL FEES ENCLOSED =				**$1,020.00**	
				Amount to be: refunded	$
				charged	$

ATTORNEY'S DOCKET NO: **011435**

U.S. APPLICATION NO. (if known) 09/926446	INTERNATIONAL APPLICATION NO. **PCT/JP00/02691**	DATE: **November 5, 2001**

a. XX A check in the amount of $ 1,020.00 to cover the above fees is enclosed. ($890.00 for basic filing fee and $130.00 for late filing of the declaration). (This paper is filed in triplicate)

b. ___ Please charge my Deposit Account No. 01-2340 in the amount of $___ to cover the above fees. (A duplicate copy of this sheet is enclosed.)

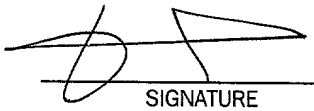
c. X The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 01-2340.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed to request that the application be restored to pending status.

Send All Correspondence To:

23850

PATENT TRADEMARK OFFICE



SIGNATURE

Ken-Ichi Hattori

NAME

32,861

REGISTRATION NUMBER

KH/yap

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Fax: (202) 887-0357

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: **Youichi HASHIMOTO**

Serial No.: **Not Yet Assigned**
(PCT/JP00/02691)

Filed: **November 5, 2001**

For: **PROGRAMMABLE CONTROLLER**

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

November 5, 2001

Sir:

Prior to the calculation of the filing fees of the above application, please amend the application as follows:

IN THE ABSTRACT OF THE DISCLOSURE:

Please add the Abstract of the Disclosure as shown on a separate page attached hereto.

IN THE CLAIMS:

Please amend claim 1 as follows:

1. (Amended) A programmable controller comprising a speed pattern generator including speed pattern generator units that receive input of all of the amount of movement, speed, acceleration, time and deceleration time and calculate a desired speed pattern for output to a servomotor, wherein

said speed pattern generator includes a plurality of said speed pattern generator units to generate a desired speed pattern by operating, either one of said arbitrary speed pattern generator units solely or said plurality of arbitrary peed pattern generator units simultaneously.

REMARKS

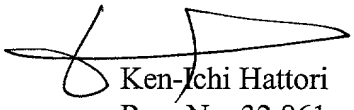
The above amendment is submitted to place the claims in substantially the same condition as to the claims which ave been amended under Article 34 in the international application. An English translation of the annexes of the PCT international preliminary examination report is enclosed. Early and favorable action is awaited.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "Version with markings to show changes made."

In the event there are any additional fees required, please charge our Deposit Account No. 01-2340.

Respectfully submitted,

ARMSTRONG, WESTERMAN, HATTORI,
McLELAND & NAUGHTON, LLP



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KH/yap

VERSION WITH MARKINGS TO SHOW CHANGES MADE

Claim 1 has been amended as follows:

1. (Amended) A programmable controller ~~which comprises~~ comprising a speed pattern generator including speed pattern generator units that receive input of all of the amount of movement, speed, acceleration, time and deceleration time and calculate a desired speed pattern for output to a servomotor, wherein

~~the~~ said speed pattern generator includes a plurality of ~~said~~ speed pattern generator units ~~and also generates~~ generate a desired speed pattern by ~~semultaneously~~ operating ~~one or more arbitrary speed pattern generator units~~, either ~~of said plurality of speed pattern generator units~~ one of said arbitrary speed pattern generator units solely or said plurality of arbitrary peed pattern generator units simultaneously.

ABSTRACT OF THE DISCLOSURE

A programmable controller comprises a speed pattern generator (12) including speed pattern generator units (12a-12n) that respond to input quantities of the amount of movement, speed, acceleration time and deceleration time by calculating a desired speed pattern for output to a servomotor (17). A desired speed pattern is generated by simultaneously operating any of the speed pattern generator units (12a-12n) of the speed pattern generator (12). The speed pattern provided by the speed pattern generator (12) is output to a console (14), on which the user can process the speed pattern freely.

DESCRIPTION

PROGRAMMABLE CONTROLLER

Technical Field

The present invention relates to a programmable controller which generates a speed command to a servomotor.

Background Art

Priorly, when generating a speed pattern by a programmable controller, as shown in the block diagram of a controller of Fig. 4, in a speed pattern generator portion 42 which automatically generates an acceleration and deceleration pattern (such as a trapezoidal wave pattern, an asymmetric pattern and the like) based on a move command 41 (processing program) giving the amount of movement, speed, acceleration time, and deceleration time, for example, a trapezoidal wave acceleration and deceleration pattern is generated, a speed command 43 including the acceleration time, specified speed, deceleration time, amount of movement represented by the area of the trapezoid, as shown in Fig. 5, is output and provided for a servo control portion 44, and a servomotor 45 is controlled by the speed command.

Also, in a case of synchronous control between two spindles (the number of main and slave spindles is not specified) having

the master-servant relationship where the slave spindle is driven in synchronization with movement of the main spindle as shown in Fig. 6, similar to the case of the speed command for one spindle (asynchronous control) as shown in Fig. 5, a speed command, which is provided for the main spindle and slave spindle, respectively, while maintaining the synchronous relationship, is automatically generated in accordance with a command from the superordinate.

However, in the above-described prior art, according to the speed pattern generating function, the move command (or a processing program) is analyzed, thereupon the speed pattern is automatically generated, therefore generation of the speed pattern has been fixed to synchronous/asynchronous timing specified by the move command and it has been impossible for a user to carry out a start/ stop at free timing.

In addition, when the speed pattern is generated by the speed pattern generating function, the calculation results are directly output to the servomotor, therefore, it has been impossible to process said speed pattern halfway and output these to the servomotor as a speed command.

Accordingly, there has been a problem such that, due to the above-described drawbacks, speed patterns other than the speed pattern provided by the controller cannot be realized.

Therefore, it is an object of the present invention to provide a speed pattern generator as one function and open the calculation results to the user without outputting the results as a command to a servomotor, whereby providing a programmable controller which is capable of providing an environment which allows the user to realize an arbitrary speed pattern.

Disclosure of Investigation

In order to achieve the above-described object, according to the first aspect of the invention, a programmable controller which comprises a speed pattern generator including speed pattern generator units that receive input of the amount of movement, speed, acceleration time, and deceleration time and calculate a desired speed pattern for output to a servomotor, wherein

the speed pattern generator includes a plurality of speed pattern generator units and also generates a desired speed pattern by simultaneously operating one or more arbitrary speed pattern generator units of said plurality of speed pattern generator units.

Also, according to the second aspect of the invention, the programmable controller comprises a user operation portion, the speed pattern generator outputs the calculated speed pattern to said user operation portion, and an output is sent from said

user operation portion to the servomotor. Moreover, according to the third aspect of the invention, the user operation portion can be started and stopped by a user at free timing.

Furthermore, according to the fourth aspect of the invention, the speed pattern generator units store trapezoidal waveforms having arbitrary shapes and a desired speed pattern is generated as a composite pattern that is geometrically superposed based on the algebraic sum of these trapezoidal waveforms.

Brief Description of Drawings

Fig. 1 is a block diagram of the program executing processing by the program controller according to an embodiment of the present invention.

Fig. 2 is a diagram showing an output example of the speed pattern generator unit shown in Fig. 1.

Fig. 3 is a diagram showing the speed command of the controller shown in Fig. 1.

Fig. 4 is a block diagram of the prior programmable controller.

Fig. 5 is a diagram showing an output example of the prior speed command.

Fig. 6 is an explanatory diagram of the prior simultaneous control.

Best Mode for Carrying out the Invention

Hereinafter, an embodiment of the present invention will be described with reference to the drawings.

Referring to Fig. 1, 10 denotes a programmable controller according to the present invention, 11 denotes a move command portion 14 for inputting a move command into a speed pattern generator 12 by a user, and 12 denotes the speed pattern generator which includes various speed pattern generator units 12a, 12b, 12c, …, 12n and outputs calculation results (a speed, a residual distance, and a delivery distance including a current amount of movement) to a results portion. 13 denotes the results portion for storing said calculation results. 14 denotes a user operation portion provided by the present invention and by superposing trapezoidal patterns of the various speed pattern generator units 12a, 12b, 12c, …, 12n inside the speed pattern generator 12 on each other by use of the results of the results portion 13, a desirable speed pattern can be easily generated. 15 denotes a speed command portion which receives an output from the user operation portion 14 and generates a speed command to be given to a servomotor. 16 denotes a servo control portion and 17 denotes a servomotor. In the program executing processing by the programmable controller shown in Fig. 1, when a user inputs the move command 11 into the speed pattern generator

12, the speed pattern generator 12 calculates a speed pattern according to said move command and outputs the speed pattern to the results portion 13.

The user freely processes the calculation results of the results portion 13 from the speed pattern generator 12 by means of the user operation portion 14 and outputs a desirable speed command for the servomotor 17 to the speed command 15 and provides this command for the servo control portion 16.

In this case, a plurality of speed pattern generator units 12a,..., 12n exist and can start/stop at a user's desirable timing.

In the output example of the speed pattern generator shown in Fig. 2, the speed, acceleration time, and deceleration time are at values specified by the user and the area of the trapezoid ABCD represents an amount of movement specified by the user.

Now, operations will be described.

In a case where the user moves the servomotor 17 by a certain amount of movement, the velocity waveform of the servomotor 17 becomes a polygon based on the trapezoid as shown in Fig. 2. When the area of this polygon is regarded as the amount of movement, a combination of trapezoids which realizes this area and polygonal shape by adding or deducting trapezoids having arbitrary shapes is determined.

Based on the combination of trapezoids thus determined,

the user inputs, while weighing the timing for realizing this polygon, the move command 11 into a plurality of speed pattern generator units 12a through 12n and obtains calculation results from each thereof. The algebraic sum of results 13 (trapezoids) from said plurality of speed pattern generator units 12a through 12n is output to the servo control portion 16 as a timely speed command 15, whereby a desirable velocity waveform can be realized.

For inputting the move command 11, a formula where a processing program is given to a controller by a CPU module is employed, whereas in the present case, it becomes possible to directly input into the speed pattern generator 12 of the controller by the user as the move command 11.

In addition, in the user operation portion 14, it is possible to perform processing (various filtering operations) to the algebraic sum waveform of values (trapezoids) of the results portion 13, which are calculation results from the speed pattern generator 12. The user operation portion 14 is constructed such that the user can perform processing such as superposition and the like by use of a mouse and the like in a dialogue manner while monitoring a polygonal waveform of the calculated results which is displaced on a display device (unillustrated).

Concretely, referring to the speed command example of Fig. 3, a case will be described, wherein a velocity waveform having a polygonal shape ABEGJIHFCD is realized.

(1) First, as shown in Fig. 3, generation of a speed pattern ABCD, which is the same as the trapezoid shown in Fig. 2, is carried out and this pattern is set as an output 1.

(2) Then, generation of a speed pattern of a trapezoid EGHF is carried out at a time t1, and since this output is in the decelerating direction, this output is deducted from the output 1 and the resulting pattern is set as an output 2.

(3) Generation of a speed pattern of a trapezoid GHIJ is carried out at a time t2, and since this output is in the accretion direction, this output is added to the output 2 and the resulting pattern is set as an output 3.

By setting such outputs 1 through 3 as a speed command to the servo control portion 16, it becomes possible to command the velocity waveform having the shape ABEGJIHFCD illustrated by the solid lines, thus making it possible to freely execute the speed command by user operations.

Such free execution of the speed command by user operations is possible irrespective of synchronous/asynchronous control. As a simple example of synchronous control, in a case where for a main spindle which carries out one cutting process with

acceleration, constant speed, and deceleration as shown in the trapezoid ABCD of Fig. 2, synchronous control such that a slave spindle which is synchronous therewith causes movement with a speed demand of the trapezoid ABCD which has been inverted without a change toward the minus region (toward the side under the 0-line of Fig. 2) is carried out, if the user rewrites the speed command of the main spindle, as the output 3 shown in Fig. 3, so as, for example, to cause the tool end to approximate to the workpiece for the acceleration time AB, carry out two cutting processes composed of two stages with acceleration and deceleration for EGJIHF, and return to the origin for deceleration time CD, the speed command of the slave spindle is also rewritten to an inverted trapezoid based on the speed command ABEGJIHFCD of the main spindle. (Furthermore, it is also possible to separately rewrite the trapezoidal speed commands of the main spindle and the slave spindle and/or to shift the timing, as the case may be.)

Thus, it becomes possible for the programmable controller (or a motion controller) to carry out generation of and rewriting of a speed command independent of a command from a superordinate device such as a CPU module and the like, and it also becomes possible to carry out correction of acceleration in a case of motion program look-ahead predictive control for a plurality

of blocks without waiting for program modifications by the superordinate device, therefore this controller effectively functions as a distributed system, whereby enabling an improvement in cycle time to improve the productivity.

As has been described above, according to the present invention, the user freely processes an output from the speed pattern generator provided by the programmable controller (or a motion controller), whereby it becomes possible to output an arbitrary speed command to the servomotor, therefore the user has an effect to improve the tact time of a machine.

Furthermore, the speed pattern generator of the present invention is similar to a shift order such as automatic acceleration and deceleration in the motion program in terms of the commanding method, therefore there is also an effect such that consistency in use is excellent and a decline in production costs can be expected.

Industrial Applicability

The present invention can provide a programmable controller where generation and processing of speed command patterns by user operation is possible, therefore it is optimal for use where complicated machine control is carried out.

WHAT IS CLAIMED IS:

1. A programmable controller which comprises a speed pattern generator including speed pattern generator units that receive input of the amount of movement, speed, acceleration, time, and deceleration time and calculate a desired speed pattern for output to a servomotor, wherein

the speed pattern generator includes a plurality of speed pattern generator units and also generates a desired speed pattern by simultaneously operating one or more arbitrary speed pattern generator units of said plurality of speed pattern generator units.

2. A programmable controller as set forth in Claim 1, wherein

the programmable controller comprises a user operation portion, the speed pattern generator outputs the calculated speed pattern to said user operation portion, and an output is sent from said user operation portion to the servomotor.

3. A programmable controller as set forth in Claim 2, wherein

the user operation portion can be started and stopped by a user at free timing.

4. A programmable controller as set forth in Claim 1, wherein

the speed pattern generator units store trapezoidal waveforms having arbitrary shapes and a desired speed pattern is generated as a composite pattern that is geometrically superposed based on the algebraic sum of these trapezoidal waveforms.

Fig. 1

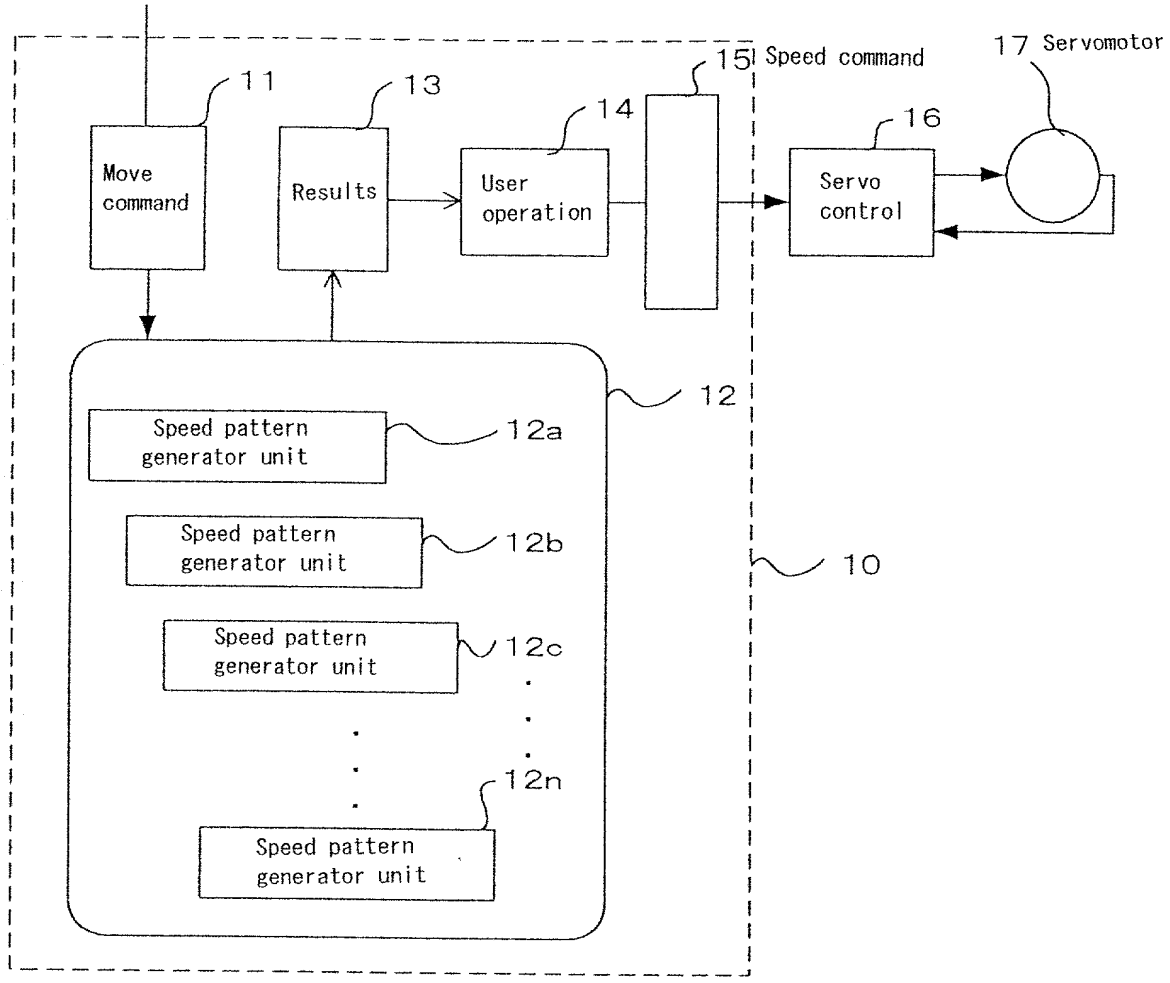

11
13
14
15
Speed command
17 Servomotor
16
Move command
Results
User operation
Servo control
12
Speed pattern generator unit
12a
Speed pattern generator unit
12b
10
Speed pattern generator unit
12c
12n
Speed pattern generator unit

Fig. 2

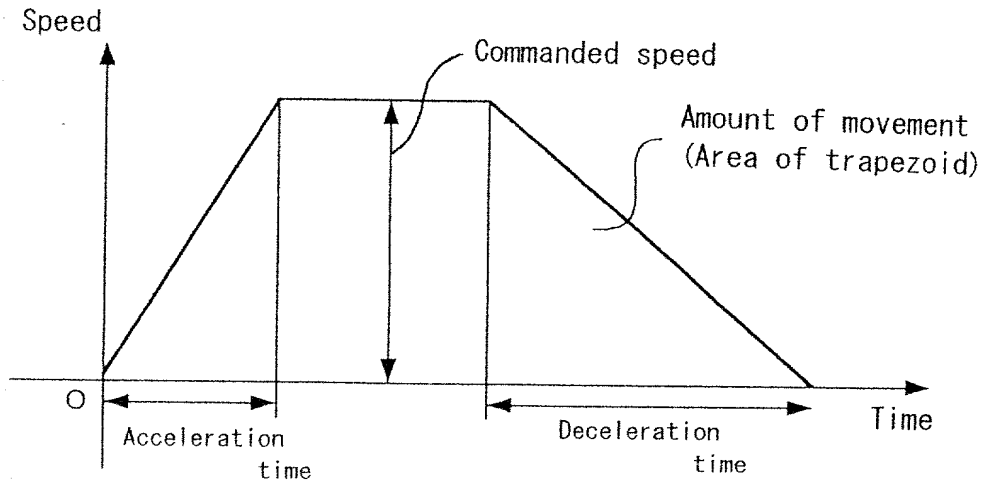

Speed
Commanded speed
Amount of movement
(Area of trapezoid)
O
Acceleration time
Deceleration time
Time

Fig. 3

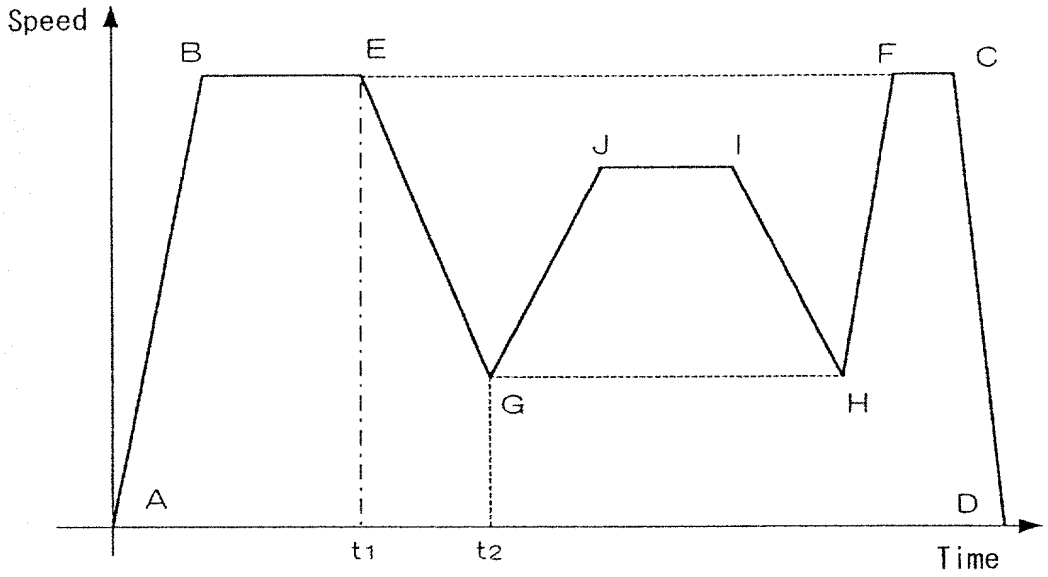

Speed
B
E
F
C
J
I
G
H
A
D
t1
t2
Time

Fig. 4

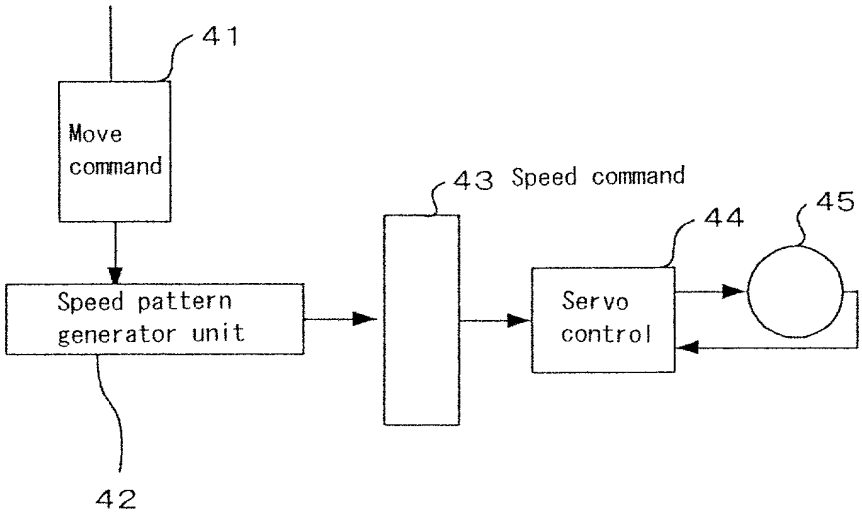

41
Move command
43 Speed command
44
45
Speed pattern generator unit
Servo control
42

Fig. 5

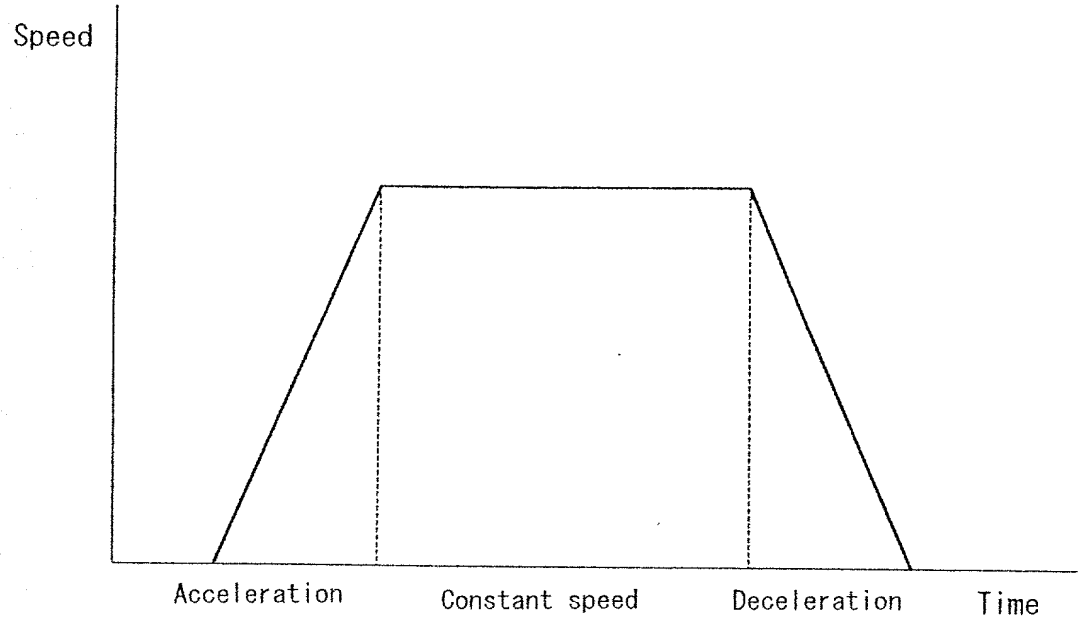
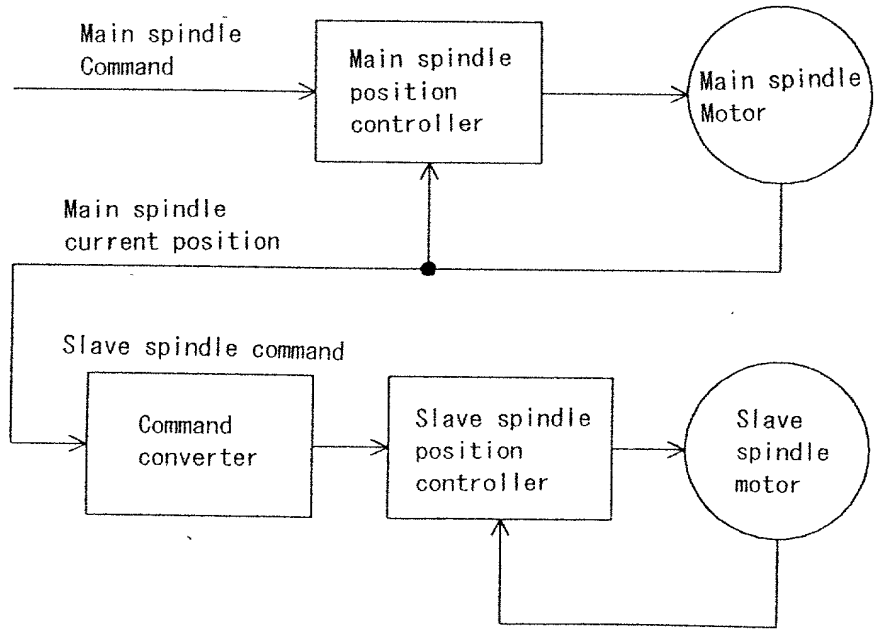

Speed
Acceleration
Constant speed
Deceleration
Time

Fig. 6


Main spindle Command
Main spindle position controller
Main spindle Motor
Main spindle current position
Slave spindle command
Command converter
Slave spindle position controller
Slave spindle motor

Docket No.

Armstrong, Westerman, Hattori, McLeland & Naughton, LLP

DECLARATION FOR U.S. PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention **entitled**

PROGRAMMABLE CONTROLLER

the specification of which is attached hereto unless the following is checked

☒ was filed on **April 24,2000** as United States Application Number _____ or PCT International Application Number **PCT/JP00/02691** and was amended on **March 5,2001** (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 (a) – (d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application for which priority is claimed.

(List prior foreign applications. See note A on back of this page)	(Number)	(Country)	(Day/Month/Year Filed)	Priority Claimed
	11-126059	**Japan**	**06/05/1999**	☒ Yes ☐ No
				☐ Yes ☐ No
				☐ Yes ☐ No
				☐ Yes ☐ No

(See note B on back of this page) ☐ See attached list for additional prior foreign applications

I hereby claim the benefit under Title 35, United States Code, ' 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, ' 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, ' 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

(List prior U.S. Applications)	(Application Serial No.)	(Filing Date)	Status
			☐ Patented ☐ Pending ☐ Abandoned

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

23850

23850

PATENT TRADEMARK OFFICE

Please direct all communications to the following address:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Title 18 of the United States Code, ' 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

(See note C)

Full name of sole or first inventor (given name, family name) 1-00 Youichi HASHIMOTO

Inventor's signature Youichi Hashimoto Date December 17, 2001

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Japan

Full name of second inventor (given name, family name)

Inventor's signature Date

Residence Citizenship

Post Office Address

Full name of third inventor (given name, family name)

Inventor's signature Date

Residence Citizenship

Post Office Address

Full name of fourth inventor (given name, family name)

Inventor's signature Date

Residence Citizenship

Post Office Address

Full name of fifth inventor (given name, family name)

Inventor's signature Date

Residence Citizenship

Post Office Address